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[Title of the Invention] LIQUID CRYSTAL PANEL, LIQUID CRYSTAL PANEL MANUFACTURING METHOD, AND LIQUID CRYSTAL PANEL DRIVING METHOD

[Abstract]

[Object] There is provided a liquid crystal display panel having good display quality, removing a display defect due to non-uniform injection of the liquid crystal display panel.

[Solving Means] With a protrusion arranged as an obstacle, flowing of a liquid crystal material supplied when the liquid crystal layer is formed is controlled, so that non-uniform injection is suppressed. In other words, the liquid crystal display panel of the present invention includes: a first substrate having a color filter; a second substrate having a predetermined gap therebetween and arranged to face the first substrate; a liquid crystal layer interposed between the first and second substrates; and a plurality of electrodes for applying a voltage to the liquid crystal layer; and at least one of first and second substrates includes a protrusion portion for controlling a flow of liquid crystal material supplied when forming the liquid crystal layer on a surface facing the other substrate.

[Claims]

[Claim 1] A liquid crystal display panel comprising:

a first substrate having a color filter;

a second substrate having a predetermined gap therebetween and arranged to face the first substrate;

a liquid crystal layer interposed between the first and second substrates; and

a plurality of electrodes for applying a voltage to the liquid crystal layer;

wherein at least one of first and second substrates includes a protrusion portion for controlling a flow of liquid crystal material supplied when forming the liquid crystal layer on a surface facing the other substrate.

[Claim 2] The liquid crystal display panel according to Claim 1,

wherein the liquid crystal layer leaves an opening as an injecting port, and is formed by injecting a liquid crystal material into an empty panel configured such that the first and second substrates bonds with each other at a peripheral portion thereof; and

wherein the protrusion portion is arranged such that a cross sectional area of a flowing path of the liquid crystal material flowing into the empty panel through the injecting port is smaller than an area of the injecting port.

[Claim 3] The liquid crystal display panel according to Claim 2,

wherein the protrusion portion has a wall perpendicular

to a flowing direction of the liquid crystal material flowing into the empty panel.

[Claim 4] The liquid crystal display panel according to Claim 2,

wherein a height of the protrusion portion is more than 1 μm.

[Claim 5] The liquid crystal display panel according to Claim 2,

wherein a length of the protrusion portion is more than 1 mm.

[Claim 6] The liquid crystal display panel according to Claim 1,

wherein the protrusion portion is formed on the first substrate, and is made of the same material as the color filter.

[Claim 7] The liquid crystal display panel according to Claim 1,

wherein the first or second substrate has a plurality of regions having different distribution densities of the protrusion portion.

[Claim 8] The liquid crystal display panel according to Claim 7,

wherein the liquid crystal layer leaves an opening as an injecting port, and is formed by injecting a liquid crystal material into an empty panel configured such that

the first and second substrates bonds with each other at a peripheral portion thereof; and

wherein the protrusion portion is arranged at a region around the injecting port in a higher distribution density than other regions.

[Claim 9] The liquid crystal display panel according to Claim 7,

wherein the region is divided into a plurality of concentric circles, and

wherein the distribution density of the protrusion portion is reduced step by step, from a region inside a circle having a smallest diameter to a region divided into a circle having a larger diameter.

[Claim 10] The liquid crystal display panel according to Claim 7,

wherein the distribution density of the protrusion portion in the peripheral portion of the substrate is higher than the distribution density of the protrusion portion in a central portion of the substrate.

[Claim 11] The liquid crystal display panel according to Claim 1,

wherein a height of the protrusion portion is the same as a gap between the first and second substrates.

[Claim 12] The liquid crystal display panel according to Claim 1,

wherein the protrusion portion serves to remove ion dopants included in the liquid crystal layer.

[Claim 13] The liquid crystal display panel according to Claim 12,

wherein the protrusion portion includes at least one selected from a group consisting of $Al_2O_3$, $TiO_2$, porous glass, porous silicon and ion exchange resin.

[Claim 14] The liquid crystal display panel according to Claim 12,

wherein the protrusion portion electrically absorbs the ion dopants.

[Claim 15] The liquid crystal display panel according to Claim 14,

wherein the protrusion portion is conductive, and electrically connected to the electrode.

[Claim 16] The liquid crystal display panel according to Claim 15,

wherein the protrusion portion includes a carbon particle or a polythiophen.

[Claim 17] The liquid crystal display panel according to Claim 12,

wherein the first or second substrate includes a charged portion for pulling the ion dopant, and

wherein the protrusion portion is arranged around the charged portion.

[Claim 18] The liquid crystal display panel according to Claim 17,

wherein the charge portion is formed by removing a dielectric layer that covers a surface of a portion electrically connected to the electrode.

[Claim 19] The liquid crystal display panel according to Claim 12,

wherein the protrusion portion is connected to the electrode directly or through an alignment layer.

[Claim 20] The liquid crystal display panel according to Claim 12,

wherein a distance between the protrusion portion and the electrode is less than 10 μm.

[Claim 21] The liquid crystal display panel according to Claim 12,

wherein the protrusion portion has concaves and convexes on a surface.

[Claim 22] The liquid crystal display panel according to Claim 21,

wherein heights of the concaves and convexes are in a range of 0.01 μm to 5 μm.

[Claim 23] The liquid crystal display panel according to Claim 1,

wherein the protrusion portion is arranged on a non-display region.

[Claim 24] A liquid crystal display panel comprising:

a first substrate having a color filter;

a second substrate having a predetermined gap therebetween and arranged to face the first substrate;

a liquid crystal layer interposed between the first and second substrates;

a plurality of electrodes for applying a voltage to the liquid crystal layer; and

a conductive protrusion portion arranged on a surface facing the liquid crystal layer of the first or second substrate and electrically connected to the electrode.

[Claim 25] A liquid crystal display panel comprising:

a first substrate having a color filter;

a second substrate having a predetermined gap therebetween and arranged to face the first substrate;

a liquid crystal layer interposed between the first and second substrates;

a plurality of electrodes for applying a voltage to the liquid crystal layer;

a charged portion arranged on a surface facing the liquid crystal layer of the first or second substrate;

a protrusion portion arranged adjacent to the charged portion and having an ion absorption capability.

[Claim 26] A liquid crystal display panel manufacturing method, the liquid crystal display panel having a first

substrate having a color filter; a second substrate having a predetermined gap therebetween and arranged to face the first substrate; a liquid crystal layer interposed between the first and second substrates; and a plurality of electrodes for applying a voltage to the liquid crystal layer, the method comprising:

cleansing the protrusion portion to remove ion dopants included in the protrusion portion.

[Claim 27] The liquid crystal display panel manufacturing method according to Claim 26,

wherein the ion dopants are removed through acid cleansing or alkali cleansing.

[Claim 28] The liquid crystal display panel manufacturing method according to Claim 26,

wherein the ion dopants are removed through alcohol cleansing or pure water cleansing.

[Claim 29] A liquid crystal display panel manufacturing method, the liquid crystal display panel having a first substrate having a color filter; a second substrate having a predetermined gap therebetween and arranged to face the first substrate; a liquid crystal layer interposed between the first and second substrates; a plurality of electrodes for applying a voltage to the liquid crystal layer; and a conductive protrusion portion arranged on a surface facing the liquid crystal layer of the first or second substrate

and electrically connected to the electrode, the method comprising:

after forming the liquid crystal layer, applying a voltage higher than an operating voltage to the electrode to absorb ion dopants included in the liquid crystal layer to the protrusion portion.

[Claim 30] A liquid crystal display panel manufacturing method, the liquid crystal display panel having a first substrate having a color filter; a second substrate having a predetermined gap therebetween and arranged to face the first substrate; a liquid crystal layer interposed between the first and second substrates; a plurality of electrodes for applying a voltage to the liquid crystal layer; a charge portion arranged on a surface facing the liquid crystal layer of the first or second substrate; and a protrusion portion arranged around the charged portion and having an ion absorption capability, the method comprising:

cleansing the protrusion portion to remove ion dopants included in the protrusion portion.

[Claim 31] The liquid crystal display panel manufacturing method according to Claim 30,

wherein the ion dopants are removed through acid cleansing or alkali cleansing.

[Claim 32] The liquid crystal display panel manufacturing method according to Claim 30,

wherein the ion dopants are removed through alcohol cleansing or pure water cleansing.

[Claim 33] A liquid crystal display panel manufacturing method, the liquid crystal display panel having a first substrate having a color filter; a second substrate having a predetermined gap therebetween and arranged to face the first substrate; a liquid crystal layer interposed between the first and second substrates; a plurality of electrodes for applying a voltage to the liquid crystal layer; a charge portion arranged on a surface facing the liquid crystal layer of the first or second substrate; and a protrusion portion arranged around the charged portion and having an ion absorption capability, the method comprising:

after forming the liquid crystal layer, charging the charged portion to absorb ion dopants included in the liquid crystal layer.

[Claim 34] A liquid crystal display panel driving method, the liquid crystal display panel having a first substrate having a color filter; a second substrate having a predetermined gap therebetween and arranged to face the first substrate; a liquid crystal layer interposed between the first and second substrates; a plurality of electrodes and gate lines for applying a voltage to the liquid crystal layer; and a conductive protrusion portion arranged on a surface facing the liquid crystal layer of the first or

second substrate and electrically connected to the electrode, the method comprising:

from applying a power to the liquid crystal display panel to performing as a display mode, applying a voltage higher than an operating voltage to the electrode to absorb ion dopants included in the liquid crystal layer.

[Claim 35] A liquid crystal display panel driving method, the liquid crystal display panel having a first substrate having a color filter; a second substrate having a predetermined gap therebetween and arranged to face the first substrate; a liquid crystal layer interposed between the first and second substrates; a plurality of electrodes for applying a voltage to the liquid crystal layer; a charge portion arranged on a surface facing the liquid crystal layer of the first or second substrate; and a protrusion portion arranged around the charge portion and having an ion absorption capability, the method comprising:

from applying a power to the liquid crystal display panel to performing as a display mode, charging the charge portion to absorb ion dopants included in the liquid crystal layer to the protrusion portion.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a liquid crystal display panel for use in a liquid crystal display device, an optical shutter, and the like, and in particular, an active matrix type liquid crystal display panel, and more specifically, to improvement in removing display defects thereof.

[0002]

[Description of the Related Art]

The conventional liquid crystal display panel has been widely used in a wrist clock, an electronic desk calculator, a personal computer, a word processor, and the like due to its merits such as thin and light weight apparatus implementation, and a low voltage driving. Recently, with development of a personal computer, and particularly, there is an increasing demand for an active matrix type liquid crystal display panel.

[0003]

An operation mode of the liquid crystal panel includes a vertically alignment type that uses a vertical electric field, and an in-plane switching type (hereinafter, referred to as an IPS type) that uses a horizontal electric field. An arrangement of a liquid crystal display panel of a twisted nematic type (hereinafter, referred to as a TN type) representing the vertically alignment type is shown in Figs. 12a and 12b. The TN type liquid crystal display panel

includes an array substrate 1 having a source line 12, a gate line 11, a source electrode 14, and an active element 13, and a color filter substrate 2 having a color filter 19, a black matrix 16 that forms a light shielding portion, a color filter 19, and a counter 15. The pixel electrode 14 and the counter electrode 15 are all made of indium tin oxide. On the array substrate 1 and the color filter substrate 2, an alignment layer 17 made of polyimide is arranged on a surface contacting with the liquid crystal layer 7, respectively. A thickness of the liquid crystal layer 7 (hereinafter, referred to as a cell gap) is uniformly maintained using a spacer 22 arranged between two substrates.

[0004]

In addition, the IPS type liquid crystal display panel is shown in Figs. 13a and 13b. For the IPS type liquid crystal display panel, unlike the TN type in terms of an electrode construction, the counter electrode 15 is arranged on an array substrate 1 having a pixel electrode 14 arranged thereon. Thus, an electric field in the horizontal direction is formed on the liquid crystal layer 7 in Figs. 13a and 13b.

[0005]

The liquid crystal display panel is not limited to the above-mentioned TN type and the IPS type liquid crystal

display panel, and includes a pair of substrates and a liquid crystal layer 7 formed therebetween. An example method of forming the liquid crystal layer 7 between two substrates includes a vacuum injection method and a dropping injection method.

[0006]

For the vacuum injection method, a liquid crystal material is injected between two substrate by contacting a pair of substrates that overlap by a predetermined gap, leave an opening as an injecting port with a peripheral portion bonded with each other (hereinafter, referred to as an empty panel), to a liquid crystal material under a reduced pressure atmosphere, and then, turning back an ambient to a normal pressure. The empty panel is manufactured by scattering spacers to retain a cell gap on one substrate of the pair of substrate having an alignment layer formed on the surface and performed in a rubbing processing, coating a sealing material on the peripheral portion of the other substrate, and then boding two substrates to cure the seal. After injecting the liquid crystal material into the empty panel, an encapsulating material is coated on the injecting port and cured by illuminating UV. Next, a polarization plate is attached to both substrates to obtain the liquid crystal display panel.

[0007]

For the dropping injection method, a substrate having spacers scattered thereon and the other substrate having the liquid crystal material dropped thereon from several syringes are bonded under the normal pressure, or under a reduced press ambient followed by the normal pressure ambient. As described above, according to the prior art, the liquid crystal material is dispersed radially from the injecting port or the dropping position to the overall panel.

[0008]

In the conventional panel, for the liquid crystal injection process, defects referred to as, so-called non-uniform injection are generated along a direction in which the liquid crystal material flows. It is appreciated that ion dopants included in the ion dopants mixed at the time of injecting the liquid crystal material or the ion dopants included in the liquid crystal material itself are generated since they are trapped at an interface between an alignment layer and a liquid crystal layer. In addition, around the injecting port, defects are also generated in that ion dopants as a non-cured element used for the sealing material are emitted into the liquid crystal material. The portion where the ion dopants are trapped and thus the ions are not uniformly distributed has a degraded voltage retention ratio at the time of driving the panel, so that it does not have

the same display as the remaining portions.

[0009]

In addition, for the TN type liquid crystal display device, which is the active matrix type, ions may be generated by backlight illumination, and thus the ions may give a bad effect on display. For the IPS type liquid crystal display, there is another display defects generated due to the construction. For example, a pinhole problem is an example thereof. In the IPS type panel, all wirings such as a pixel electrode, a counter electrode, a source line, and a gate line are covered with a dielectric layer such as $SiO_2$ or $SiN_x$. Due to debris and the like, when the pinhole, i.e., a portion where the dielectric layer is broken down and the electrode is directly exposed to the liquid crystal layer, is generated, the portion has display defects for the high temperature operation. For example, when the pinhole is formed on the gate line, the potential of the gate line is in a negative electrode for the most part, so that the ion dopants in the liquid crystal layer are collected at the pinhole portion and thus the display defect is generated.

[0010]

For the liquid crystal display panel for use in the vertical electric field such as the TN type and OCB type, and active matrix type liquid crystal display panel including the liquid crystal display panel for use in the

horizontal electric field such as the IPS type liquid crystal display panel, it is particularly important to have a good voltage retention ratio in obtaining the display. In particular, the IPS type liquid crystal display panel is a display mode where the liquid crystal around the interface is more attributable, so that it is easily affected to the ions absorbed around the interface. Once these ion dopants are mixed into the panel, it is impossible to remove them to the outside, and becomes a factor to decrease the throughput of the panel. Therefore, in the liquid crystal display panel manufacturing process, it is necessary to significantly remove the effect of the ion defects.

[0011]

Therefore, various methods are proposed in order to prevent the ion dopants from being mixed to the liquid crystal layer, or remove the mixed dopants. Japanese Unexamined Patent Application Publication No. 7-175073 discloses a method of arranging a defect absorbent around the filling port. In the above publication, in order to prevent the ionic material or a low molecular weight material from infiltrating into the liquid crystal layer, arranging the absorbent made of aluminum oxide coating layer on the substrate surface around the liquid crystal filling port is proposed, or arranging the pillar shaped body is arranged to divide the filling port and placing the same

absorbent on the surface is also proposed.

[0012]

In Japanese Unexamined Patent Application Publication No. 6-110064 discloses a proposal to disperse miniscule made of ion absorbing material in the liquid crystal layer, or a proposal to use a spacer made of ion absorbing material, in order to remove ion dopants infiltrated into the liquid crystal layer. In any of these prior arts, the effect on, so-called, the non-uniform injection cannot be expected.

[0013]

[Problems to be Solved by the Invention]

The present invention is contrived to solve the above problems, and an object of the present invention is to provide a liquid crystal panel having a less display non-uniformity due to non-uniform injection. In addition, another object of the present invention is to provide a liquid crystal display panel capable of suppressing non-uniform display due to other factors and performing a better display.

[0014]

According to the present invention, a protrusion is arranged as an obstacle when the liquid crystal layer is formed, and thus liquid crystal flowing is controlled and non-uniform injection is suppressed. An aspect of the present invention provides a liquid crystal display panel

comprising: a first substrate having a color filter; a second substrate having a predetermined gap therebetween and arranged to face the first substrate; a liquid crystal layer interposed between the first and second substrates; and a plurality of electrodes for applying a voltage to the liquid crystal layer. Here at least one of first and second substrates may include a protrusion portion for controlling a flow of liquid crystal material supplied when forming the liquid crystal layer on a surface facing the other substrate.

[0015]

For the vacuum injection method, the protrusion portion is arranged around the injecting port. With the protrusion portion, a flowing path of the injected liquid crystal material is reduced, so that flowing rate is lowered and flowing can be dispersed since a so-called turbulence is generated. With this, the ion dopants included in the liquid crystal material is more uniformly distributed, so that the effect of display defect is reduced. In addition, since the flowing rate is lowered due to the obstacle, an alignment layer is trapped before ion dopants reach the region where the electrode is formed, and as a result, the display defect can be prevented.

[0016]

To relieve a rapid flowing of the liquid crystal material, it is more effective that the protrusion portion

has a wall perpendicular to the flowing direction of the injected liquid crystal material. A plurality of protrusion portions may be formed. In the present invention, a large protrusion portion throughout several pixels and a small protrusion portion smaller than a first pixel can be used. Preferably, a height of the protrusion portion is more than 1 μm, and a length thereof is more than 1 mm. In addition, the protrusion portion is not limited to a rectangular parallel-piped, but may be a cylinder, a cone, a truncated cone, a polygonal pyramid, and other shapes.

[0017]

The protrusion portion is arranged on at least one of the array substrate and the counter substrate. When the protrusion portion is formed on the counter substrate, it is preferably formed along with the color filter using the known method (e.g., photolithography, a pigment dispersion method, a print method, an inkjet method, an electro-deposition method, and a dying method) using the material such as a color filter, in which a new process need not be added. In addition, in order to form the protrusion portion in a desired height, color filter materials having different two or three colors overlap, or a black matrix (light shielding layer) and a color filter overlap.

[0018]

When the protrusion portion is formed on the array

substrate, it is preferable that the protrusion portion is formed along with a material such as, for example, a dielectric layer or an electrode. In addition, the protrusion portion may be formed after a rubbing process to the alignment layer. The protrusion portions are advantageously arranged on a plurality of regions where a distribution density of the protrusion portion is different from each other. In the vacuum injection method, the protrusion portion is arranged in a distribution density higher than other regions.

[0019]

For the dropping method, the liquid crystal material is radially diffused from dropped positions, and thus, for example, a plurality of regions divided into concentric circles is arranged such that a distribution density of the protrusion portion is established for each region. By setting the distribution density of the protrusion portion of the inside region having the smallest diameter, the distribution density of the protrusion portion is reduced step by step, from a region inside a circle having a smallest diameter to a region divided into a circle having a larger diameter.

[0020]

In addition, an example factor to cause non-uniformity includes emission from the sealing material arranged at a

peripheral portion of the panel. Therefore, with the distribution density of the protrusion portion in the peripheral portion of the substrate being higher than the distribution density of the protrusion portion in a central portion of the substrate, a speed of contacting the sealing material with the liquid crystal display at the time of injecting the liquid crystal material is reduced, and thus the emission is suppressed. By matching height of the protrusion portion to a gap between the first and second substrates, the protrusion portion can serve as a spacer.

[0021]

The conventionally used spherical or fabric shaped spacers are dispersed in an undefined place on the substrate, so that the contrast of the display is affected. With respect to this, when the protrusion arranged in advance at the established position is used as a spacer, the image quality is improved since the display defect due to the non-uniform injection can be solved and the contrast can be improved.

[0022]

In addition, when the protrusion portion also serves to remove ion dopants included in the liquid crystal layer, the display defect can be effectively reduced. The protrusion portion includes a material serving to physically or chemically remove ion dopants, for example, $Al_2O_3$, $TiO_2$,

porous glass, porous silicon and ion exchange resin. In addition, a protrusion portion having a surface coated with the above method may be used.

[0023]

It is also advantageous that the ion dopants are electrically adsorbed with the protrusion portion. For example, using a conductive protrusion portion, the protrusion portion is electrically connected to the pixel electrode or the counter electrode. The conductive protrusion portion may include a resin dispersed with a conductive material such as carbon, a conductive resin such as polythiophen, or metal. Here, the protrusion made of a non-conducting body having a surface coated with a conductor can be used. In addition to forming the protrusion portion directly on the electrode, the protrusion portion may be formed on an alignment layer that covers the electrode.

[0024]

In addition to a method of absorbing ion dopants directly on the protrusion portion as described above, the charge portion other than the protrusion portion is arranged, and the protrusion portion having ion absorption capability may be arranged adjacent thereto. The charged portion is formed by, for example, removing a dielectric layer that covers a surface of the portion electrically connected to the electrode. For the physical and chemical absorption as

well, the protrusion portion is preferably connected to the electrode directly or through the alignment layer. When the ion dopants induced by the protrusion arranged around the electrode at the time of applying the voltage are absorbed, the ion dopants can be more effectively removed. When the protrusion portion is arranged at the position separated from the electrode, a distance between the protrusion portion and the electrode is determined to be less than 10 μm.

[0025]

Convexes and concaves are arranged on a surface of the protrusion portion to increase the surface area, so that the ion dopants can be more effectively removed. Preferably, a difference of heights of the convexes and concaves is in a range of 0.01 μm to 5 μm, and more preferably, in a range of 0.01 μm to 1 μm. The protrusion portion as described above can be formed through the known technology at the predetermined places. Therefore, by arranging the protrusion portion in a non-display region, the effect on the display can be removed.

[0026]

In the present invention, any type of liquid crystal material such as a nematic liquid crystal, a ferroelectric liquid crystal, and a semi-ferroelectric liquid crystal may be used. Either operation mode of a vertically alignment

method and an in-plane switching using a horizontal electric field may be used as a liquid crystal display panel.

[0027]

In addition, a liquid crystal display panel using a three terminal device, i.e., TFT, a two terminal device, i.e., MIM (metal-insulator-metal), ZnO barrister, SiNx diode, and a-Si diode, as an active element, or alternatively a passive type liquid crystal display panel such as TN or STN and the like may be used. The substrate may use a glass plate, a resin film, a resin plate, and the like.

[0028]

When the reflection type liquid crystal display panel is used, the present invention may use colored dielectric layer or colored aligned layer. In addition, when a method of forming an alignment layer not using the rubbing (e.g., a method of forming the alignment layer by light) is used, the more uniform alignment can be obtained, so that the better contrast is provided.

[0029]

In a liquid crystal display panel manufacturing method of the present invention, while manufacturing the liquid crystal display panel, cleansing the protrusion portion to remove ion dopants therein is prepared. In the cleansing step, for example, ion dopants are removed in acid cleansing or alkali cleansing. In addition, ion dopants may be

removed in alcohol cleansing or pure water cleansing.

[0030]

In another liquid crystal display panel manufacturing method of the present invention, for the manufacturing of the liquid crystal display panel including a protrusion portion having the above-mentioned ion absorption capability, applying a voltage higher than an operating voltage to an electrode or charging a charge portion, after forming the liquid crystal layer, the ion dopants included in the liquid crystal layer are absorbed on the protrusion portion. In addition, when the same process is established at the time of using the liquid crystal display panel, for example, from applying a power to the liquid crystal display panel to performing in a display mode, the display defect is effectively suppressed.

[0031]

[Embodiments]

Preferred embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

[0032]

[First Embodiment]

In the present embodiment, a preferred example for suppressing, so-called, non-uniform injection is described. A liquid crystal display panel of the present embodiment is

shown in Figs. 1a and 1b. As shown in Fig. 1b, a counter electrode 2 includes a protrusion portion 6 at a height of 3 μm, and a width of 6 mm, in a position of 3 mm from the injecting port 10. When a color filter (not shown) is formed on the counter substrate 2, the protrusion portion 6 is formed using the same material. In the present embodiment, each color filter including red, green and blue is formed through photolithography using an acrylic based thermosetting resin into which respective pigments are dispersed. In the present embodiment, the protrusion portion 6 includes two layers formed when respective color filter are formed. Like this, by using the protrusion portion 6 made of the same material as the color filter, the protrusion portion can be formed at the same time with the color filter, and thus a new step will not be needed to form the protrusion portion 6.

[0033]

In the present embodiment, using the counter substrate 2 having the protrusion portion 6, the liquid crystal display panel was manufacturing as described below. On a surface of the substrate 1 having electrodes and wirings (not shown) formed thereon, and a surface of the counter substrate 2 having a protrusion portion 6 and a color filter (not shown) formed as described above, a solution type polyimide (SE7992: manufactured from Nissan Chemical

Industries, Ltd.) is coated, and a polyimide layer is formed after annealing at 80□ for 1 minutes, followed by annealing at 220□ for 1 hour in order to perform preliminary curing.

[0034]

In order to align the liquid crystal on the polyimide layer in a specific direction, a rubbing processing that rubs the cloth in one direction is processed to form the alignment layer, and then, the substrates 1 and 2 are cleansed. Next, a sealing material 3 (Stract Bond: manufactured from Mitsui Toatsu Chemicals, Inc.) was left at a portion to be the injection port 10, as shown in Fig. 1a, and coated on the peripheral of the counter substrate 2 through printing. In addition, a glass fiber of 5.0 μmφ (manufactured from Nippon Electric Glass, not shown) was mixed in advance into the sealing material as a spacer. Next, to have the cell gap, resin balls (Eposter: GP-HC: Nippon Shokubai Co., Ltd.) having a diameter of 5.0 μm were scattered as the spacers (not shown) in a display region.

[0035]

Next, in order to electrically connect the array substrate 1 to the counter substrate 2, a conductive paste 5 is coated on the substrate end, and then, the substrates 1 and 2 are bonded. The substrate 1 and 2 are heated at 150□ for 2 hours to cure the sealing material 3, and thus an empty panel is obtained. A liquid crystal material (MT5087:

manufactured from Chisso Corporation) was injected into the obtained empty panel through a vacuum injection method. In other words, under the reduced pressure ambient, the injecting port 10 of the empty panel contacts with the liquid crystal material, and then, the ambient returns to the normal pressure, so that the material is injected into the panel. After forming the liquid crystal layer 7 by injecting the liquid crystal material, a thermosetting resin (Loctite 352A: manufactured from Loctite Japan Corporation) was coated into the injecting port 10 on the entire injecting port 10 as the encapsulating material 4, and light was illuminated for 5 minutes in 10 $mW/cm^2$ for 5 minutes.

[0036]

A planarization plate (NPF-HEG1425DU: manufactured from Nitto Denko Corporation) was attached to an outer surface of the substrate 1 and 2, respectively, so that liquid crystal display panel was obtained. The obtained panel was configured as a module and driven, and the display defect due to the non-uniform injection was not observed.

[0037]

In addition, as shown in Figs. 2a and 2b, the liquid crystal display panel having the protrusion portion 6 formed thereon was manufactured around the injecting port in the same pattern, using the sealing material. The protrusion portion 6 bonds the substrates 1 and 2. In other words, a

height of the protrusion portion 6 is equal to the cell gap. When the obtained panel was driven, it was observed that there is some non-uniformity in the display region 8 at the injecting port 10. The non-uniformity was significantly observed when the liquid crystal display panel is configured as a module, and driven in the low frequency (e.g., 10 Hz) rather than in the common driving frequency 60 Hz. From this, the non-uniformity is due to an element included in the sealing material, for example, an element remaining in the empty panel that is volatized in curing, a non-curing element of the sealing material, and ion dopants molten in the liquid crystal included in the sealing material in advance. Therefore, in order to suppress the display defects more effectively, it is desirable that the substrate having the protrusion portion formed in advance is bonded to manufacture the panel, as in the present embodiment.

[0038]

In addition, as shown in Fig. 3b, the protrusion portion 6 may be formed on the array substrate 1. In this case, when a metal layer or a dielectric layer formed in the array forming process is processed to form protrusion portion 6, a new process will not be needed in forming the protrusion portion 6. Of course, as shown in Fig. 4, the protrusion portions 8 and 6 may be arranged on the substrates 1 and 2, respectively. In addition, as shown in

Figs. 5 and 6, when a plurality of protrusion portions 6 are arranged, the liquid crystal material flowing into the empty panel is more effectively stirred, so that the non-uniform injection can be solved.

[0039]

In the present embodiment, an example is described in which the liquid crystal display panel of the first embodiment also has a function to remove ion dopants infiltrated into the liquid crystal layer 2. In the present embodiment, the protrusion portion 6 is formed using an acrylic based thermosetting resin into which aluminum oxide powders are dispersed, in the same manner as the first embodiment. The aluminum oxide absorbs ion dopants such as $Na^+$, so that the protrusion portion 6 removes the ion dopants included in the liquid crystal material flowing into the empty panel.

[0040]

In addition, the absorbent as described above may be included in the protrusion portion 6 of the liquid crystal display panel shown in the first embodiment. As described above, according to the present embodiment, the display defects caused by the non-uniform flowing as well as other factors such as the pinhole can be reduced, so that the liquid crystal display panel having favorable display quality is obtained.

[0041]

[Third Embodiment]

In the present embodiment, an example of manufacturing the TN type liquid crystal display panel through a vacuum injection method is described. The liquid crystal display panel of the present embodiment is shown in Fig. 7. The above panel includes the protrusion portion 6 inside the injecting port 10 of the empty panel in the same manner as the first and second embodiments. The protrusion portion 6 is formed at the same time with the sealing material 3, and has the same function as those in the liquid crystal display panel of the first and second embodiments.

[0042]

In the present embodiment, in addition, a plurality of protrusion portions in a circular truncated cone pillar shape (not shown, hereinafter, referred to as a circular cylinder protrusion portion) is arranged on the non-display region. The circular cylinder protrusion has a height of 4.0 μm and a diameter of 20 μm. The pillar shaped protrusion portions are distributed in different densities on a region A contacting with the injecting port 10, a region B contacting with the region A, and a region C that is a non-display region. The pillar shaped protrusion portions are arranged in a ratio such as 1 for region corresponding to 1 pixel in the region A, 1 for 4 pixels in

the region B, and 1 for 6 pixels in the region C. In other words, in the non-display region, when close to the injecting port, the pillar shaped protrusion ports are arranged more densely. The pillar shaped protrusion portion arranged in the non-display region causes the flowing resistance to be large at the time of injecting the liquid crystal material, and thus a path to the display region 8 will be longer, as more and more liquid crystal material is injected. The injected liquid crystal material passes through the region A where the pillar shaped protrusion portions are densely arranged, and passes through the regions B and C while the progressing in the flowing direction is blocked due to the protrusion portions, as shown in arrow in Fig. 7. With the above arrangement, the ion dopants included in the liquid crystal material at the time of injection can be easily trapped to the alignment layer of the non-display region.

[0043]

In addition, the pillar shaped protrusion portions are arranged at a ratio of 1 for the 9 pixels in the display region 9. In the present embodiment, both the pillar shaped protrusion portions 8 in the display region and the pillar shaped protrusion portions 8 in the non-display region have heights equal to the cell gap. Like this, by arranging the pillar shaped protrusion portions throughout the overall

region, the pillar shaped protrusion portion can serve as a spacer.

[0044]

The pillar shaped protrusion portion is formed, for example, using the material for the color filter, in the same manner as the protrusion portion of the above embodiment. As shown in Figs. 8a and 8b, the pillar shaped protrusion portion 18 in the display region is arranged on the position corresponding to, for example, a gate line 11 on the array substrate. The array substrate 1 is made of a glass substrate 9 including an active element 13 and a transparent pixel electrode 14. An alignment layer made of polyimide is formed on a surface facing the liquid crystal layer.

[0045]

The color filter substrate 2 is made of a glass substrate 9 including red, green, and blue color filter (not shown) as a pixel portion; a black matrix 16 as a light shielding portion; and a transparent counter electrode 15. An alignment layer 17 made of polyimide is formed on a surface facing the liquid crystal layer 7. The counter electrode 15 is interposed between the alignment layer 17 and the liquid crystal layer 7, and arranged to face the pixel electrode on the array substrate 1. The pillar shaped protrusion portion 18 is formed on the black matrix 16,

which is to be a light shielding portion of the color filter substrate 2.

[0046]

The liquid crystal display panel of the present embodiment is manufactured through the following method, for example. First, according to the conventional color filter substrate manufacturing method, red, green and blue color filters 19 and the black matrix 16 are formed on a surface of one side of the glass 9. Next, using a thermosetting resin (Optoma NN700: manufactured from JSR), a layer having a thickness of about 4 μm is formed through a spin coating method. After pre-bake, only a place of the obtained layer where the pillar shaped protrusion portion 18 is to be formed is exposed to cure the thermosetting resin of the corresponding place. After post-bake, the color filter substrate 2 is etched, and thus a pattern of the pillar shaped protrusion portion is left on the color filter substrate 2. In addition, by performing annealing with an oven, the pillar shaped protrusion portion 18 is formed. Here, a diameter of the formed pillar shaped protrusion portion is determined to be 20 μm, which is less than 20 μm of the black matrix 16.

[0047]

With the color filter substrate 2 obtained as described above, and the array substrate 1 manufactured in a

predetermined method, the liquid crystal display panel is manufactured. It was estimated by putting the obtained panel into a constant temperature tub of 70□, driving it for 120 hours, and displaying a gray level. Moreover, as a comparative example, it was estimated in the same manner by manufacturing the protrusion portion and the liquid crystal display panel not having the protrusion portion. As a result, the non-uniform display was observed in the panel of the comparative example, while a favorable display without the display defect can be performed in the panel of the present embodiment.

[0048]

[Fourth Embodiment]

In the present embodiment, an example is described in which the liquid crystal display panel of the third embodiment has a function to remove the ion dopants infiltrated into the liquid crystal layer 2. In the present embodiment, using a paste obtained by dispersing aluminum oxide miniscule containing Ni into the thermosetting resin for use in the third embodiment, the pillar shaped protrusion portion 18 is formed in the same manner as the third embodiment. The Ni containing aluminum oxide used herein is obtained by drying aluminum oxide power that dips into nickel acetate solution, oxidizing the aluminum oxide power at 230□, and reducing it with hydrogen. Aluminum

oxide absorbs ion dopants such as $Na^{+}$. In addition, Ni facilitates absorbing action of aluminum oxides as catalyst. Therefore, the pillar shaped protrusion portion 18 can remove the ion dopants contained in the liquid crystal material that is to flow into the empty panel. Thus, the display defect can be reduced more effectively than in the liquid crystal display panel of the third embodiment.

[0049]

[Fifth Embodiment]

In the present embodiment, a display panel manufactured by the dropping injection method will be described. According to the present invention, as shown in Fig. 9a, pillar shaped protrusion portions 18 are formed in different densities in circular regions A, B, and C all centering on a point the liquid crystal material drops, in the color filter substrate 2. The pillar shaped protrusion portion 18 is formed in a ratio of 1 for one pixel in the circular region A having a radium of 3 cm including a dropping position of the liquid crystal material. In the region B surrounding the region A and having an outer radius of 6 cm, the pillar shaped protrusion portion 18 is formed in a ratio of 1 for every three pixels, and in the region C surrounding the region B and having an outer radius of 9 cm, the pillar shaped protrusion portion 18 is formed in a ratio of 1 for every 6 pixel. In addition, in the remaining regions, the

pillar shaped protrusion portion 18 is formed in a ratio of 1 for 9 pixels. In other words, the pillar shaped protrusion portions 18 are arranged on the color filter substrate 2 such that the distribution density of the pillar shaped protrusion portion 18 is highest at the center and is reduced step by step, as the region is far from a center. In addition, some pillar shaped protrusion portions 18 are arranged on the black matrix 16, i.e., the light shielding portion, as shown in Fig. 9b.

[0050]

The liquid crystal material supplied on the color filter substrate 2 spreads the overall panel, while gradually reducing a speed centering on the dropping position. By arranging the pillar shaped protrusion portion 18 as an obstacle along a path of the liquid crystal material that radially spreads, the progressing direction of the liquid crystal material can be changed into the peripheral of the pillar shaped protrusion portion 18. In other words, while the liquid crystal material spreads over the color filter substrate 2, the ion dopants included in the liquid crystal material spreads into the liquid crystal material, so that the display defect is suppressed.

[0051]

In the present embodiment, the display panel is manufactured through a dropping injection method as

described below. First, the pillar shaped protrusion portion 18 is formed using the thermosetting resin as in the third embodiment, and in addition, the sealing material 3 is coated on the peripheral portion of the color filter substrate 2 having an alignment layer (not shown) arranged thereon, through screen printing. From three dropping syringes arranged in series over the color filter substrate 2, the liquid crystal materials are dropped toward a center point of 3 triple circles shown at the left side of Fig. 9a. After supplying the liquid crystal material on the color filter substrate 2, the array substrate having electrodes formed in advance thereon is arranged to face the color filter substrate 2 by the gap of 10 mm, and then, two sheets of substrates are aligned. Next, by reducing a pressure in the chamber, two substrates are bonded.

[0052]

The liquid crystal display panel obtained as described above is driven in conjunction with the conventional liquid crystal display panel not having the pillar shaped protrusion portion 18. While the radially non-uniform display is observed from the dropping position of the liquid crystal material for the conventional liquid crystal display panel, the liquid crystal display panel of the present invention can show favorable display.

[0053]

[Sixth Embodiment]

In the present invention, an example method of effectively removing the ion dopants of the liquid crystal layer using an electrical reaction will be described. The liquid crystal display panel of the present embodiment is shown in Figs. 10a and 10b. In the liquid crystal display panel of the present embodiment, as shown in Fig. 10b, the pillar shaped protrusion portion 18 arranged on the color filter substrate 2 is electrically connected to the counter electrode 15. In addition, the pillar shaped protrusion portion 18 is arranged on the light shielding portion.

[0054]

The above-mentioned liquid crystal display panel of the present embodiment is manufactured through the following method. The counter electrode 15 made of a transparent conductor such as ITO is formed on the glass plate 9. Next, using a paste obtained by dispersing carbon powers into a thermosetting resin (Optoma NN700: manufactured from JSR), a layer having a thickness of about 4 μm is formed on the counter electrode 15 through a spin coating method. After pre-bake, only a place of the obtained layer where the pillar shaped protrusion portion 18 is to be formed is exposed to cure the thermosetting resin of the corresponding place. After post-bake, the layer is etched and the cured resin is left on the glass plate 9.

[0055]

In addition, by performing annealing with an oven, the pillar shaped protrusion portion 18 is formed. Here, by controlling the temperature of annealing, the curing contraction of the pillar shaped protrusion portion can be controlled. When dried at high temperature, a crack is generated due to a difference of a contraction ratio between the surface and the inside of the protrusion portion and thus a surface area of the protrusion portion become larger, which is more advantageous. However, the resin is carbonated, so that it is necessary to dry the protrusion portion at the proper temperature using the resin. In addition, a diameter of the manufactured pillar shaped protrusion portion 18 is 20 μm less than the width (25 μm) of the black matrix 16.

[0056]

Next, the color filter 19 and the black matrix 16 are formed on the counter electrode 15 to obtain the color filter substrate 2. Using the color filter substrate 2 and the array substrate 1 manufactured in advance, the panel is manufactured in a predetermined method. Here, as shown in Fig. 10b, the array side of the pillar shaped protrusion portion 18 is thinner than that of the color filter. As the pillar shaped protrusion portion 18 is conductive, when the alignment accuracy between the array substrate 1 and the

color filter substrate 2 is poor, the electrode between the adjacent pixels might be short. Therefore, when a portion that contacts with the array side of the pillar shaped protrusion portion 18 is made smaller, a strict alignment accuracy between the array substrate 1 and the color filter substrate 2 can be relieved, so that the short to the pixel can be prevented.

[0057]

It was estimated by putting the obtained panel into a constant temperature tub of 70□, driving it for 120 hours, and displaying a gray level. As a result, the non-uniform display was not observed in the liquid crystal display panel of the present embodiment, and thus favorable display can be performed. In addition, after the alignment 17 is formed, even when the pillar shaped protrusion portion 18 is formed thereon, the pillar shaped protrusion portion 18 and the counter 15 are electrically connected, so that the same effect as described above can be obtained.

[0058]

[Seventh Embodiment]

In the present embodiment, another example method of effectively removing the ion dopants in the liquid crystal material for a so-called display region, using electrical reaction will be described. The liquid crystal display panel of the present embodiment is shown in Figs. 11a and 1b.

This panel is a so-called IPS type, in which the pixel electrode 14 and the counter electrode 15 are arranged together on the array substrate 1. A storage capacity portion 20 is arranged on the array substrate 1 to face the gate line 11. The storage capacity portion 20 is electrically connected to the pixel electrode 14. In the present invention, of the transparent dielectric layer 21, a portion formed on an upper surface of the storage capacity portion 20 is removed to form the opening.

[0059]

Further, for the color filter substrate 2, a conductive pillar shaped protrusion portion 18 made of the carbon power dispersed resin is formed on the black matrix 16, i.e., the light shielding portion, in the same manner as in the sixth embodiment. When the array substrate 1 and the color filter substrate 2 are bonded, the pillar shaped protrusion portion 18 is arranged at a position to face the corresponding position of an opening 20a arranged at the storage capacity portion 20 of the array substrate 1.

[0060]

For the liquid crystal display panel of the present embodiment manufactured using the above-mentioned array substrate 1 and the color filter substrate 2, the opening 20a and the pillar shaped protrusion portion 18 is electrically connected. Here, for the gate line 11, a

negative potential is biased and a positive potential is relatively applied to the pixel electrode 14. Therefore, the pillar shaped protrusion portion 18 electrically connected to the pixel electrode 14 acts as a positive electrode, and thus is able to accumulate negative ions.

[0061]

It was estimated by putting the obtained panel into a constant temperature tub of 70□, driving it for 120 hours, and displaying a gray level. As a result, the non-uniform display was not observed in the liquid crystal display panel of the present embodiment, but favorable display can be performed. In addition, after the alignment 17 is formed, the pillar shaped protrusion portion 18 may be formed thereon.

[0062]

[Eighth Embodiment]

In the present embodiment, an example method of chemically removing ion dopants in the liquid crystal is described. In the present embodiment, an array substrate having an opening arranged on the storage capacity portion is used in the same manner as in the seventh embodiment.

[0063]

Using the paste made of the thermosetting resin into which the nickel containing aluminum oxide as used in the fourth embodiment, the pillar shaped protrusion portion 18

was formed at a position on the color filter substrate 2 corresponding to the opening 20 arranged in the array substrate 1. By doing so, the liquid crystal display panel is manufactured using the color filter substrate 2 having the pillar shaped protrusion portion 18 formed on the surface. For the liquid crystal display panel of the present embodiment, the ion dopants electrically induced to the opening 20a arranged on the array substrate 1 is trapped with the pillar shaped protrusion portion 18.

[0064]

In addition, It was estimated by putting the obtained panel into a constant temperature tub of 70□, driving it for 120 hours, and displaying a gray level. As a result, favorable display without the non-uniform display can be obtained. Here, the pillar shaped protrusion portions is not necessarily arranged to contact with the opening, but may be arranged around the opening, so that the ion dopants induced can be trapped to the opening, in which the same effect can be obtained.

[0065]

[Ninth Embodiment]

In the present embodiment, through the chemical reaction, an example method of removing ion dopants in the liquid crystal is described. In the present embodiment, an array substrate having the opening arranged on the surface

of the storage capacity portion is used in the same manner as in the seventh embodiment.

[0066]

A negative ion exchange resin having ion absorption capability is dispersed in the thermosetting resin as described above was manufactured. Using the obtained paste, the pillar shaped protrusion portion having a height of 4 μm was formed in the same method as in the above embodiment, for a half of the positions on the color filter substrate corresponding to the opening arranged on the array substrate. The powder containing a positive ion exchange resin was dispersed into the thermosetting resin was manufactured in the same manner. Using the obtained paste, the pillar shaped protrusion portion having a height of 4 μm was formed on the color filter substrate at the positions the pillar shaped protrusion portions are not formed and at the ends corresponding to the opening arranged on the array substrate.

[0067]

Next, by doing so, a deionization processing was performed in which the substrate having the pillar shaped protrusion portion as described above is cleansed in the order of sulfuric acid, pure water, alcohol, alkali, pure water, and alcohol. Using the color filter substrate obtained like this, the liquid crystal panel was manufactured. It was estimated by putting the obtained

panel into a constant temperature tub of 70□, driving it for 120 hours, and displaying a gray level. As a result, favorable display can be obtained in the panel of the present embodiment. This is because that the ion dopants accumulated in the negative electrode can be trapped at the pillar shaped protrusion portion. In addition, the pillar shaped portion is not necessarily arranged to contact with the opening, but may be arranged around the opening, so that the same effect can be obtained.

[0068]

[Tenth Embodiment]

In the present embodiment, a method of manufacturing a liquid crystal panel having the above-mentioned ion dopants removal capacity will be described. As described in the above embodiment, a method of charging the protrusion portion to electrically absorb the ion dopants to the protrusion portion, or a method of arranging a charging portion to electrically draw the ion dopants to absorb the ion dopants to the protrusion portion adjacent to the charging portion can be performed in a more strict condition to achieve the better effect. However, when actually used, the voltage applying condition to the protrusion portion or the charging portion is restricted by an operating condition of the liquid crystal display panel. Therefore, while manufacturing products, the above-mentioned ion dopants are

removed in advance under the strict condition.

[0069]

For a process from liquid crystal injection to the product completion, as an ion absorption driving, a high voltage of ±30V is applied to the ion absorption portion of the overall screen at the frequency of 60 Hz. This ion absorption driving is preferably performed at the same time with lighting performed before mounting an IC.

[0070]

[Eleventh Embodiment]

The ion absorption driving as described above may be advantageously performed at the initial stage of the apparatus. At the initial stage of a panel driving, i.e., whenever the power is applied, the voltage of +20V and -10V is applied to the gate electrode at 60 Hz in a certain time. During the ion absorption driving, the backlight does not turn on. Next, display is performed through the common driving. At the initial stage of the apparatus, ions are absorbed for each time of driving, so that favorable display without a defect for a long time can be obtained.

[0071]

[Effect]

According to the present invention, display defects of a liquid crystal display panel due to a so-called non-uniform injection can be suppressed. In addition, other

display defect factors due to ion dopants mixed in the liquid crystal can be removed. Therefore, a liquid crystal display panel having good display characteristics can be provided.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1a is a plan view showing a liquid crystal display panel according to an embodiment of the present invention; and Fig. 1b is a cross sectional view showing an essential part of the panel.

[Fig. 2]

Fig. 2a is a plan view showing a liquid crystal display panel according to another embodiment of the present invention; and Fig. 2b is a cross sectional view showing an essential part of the panel.

[Fig. 3]

Fig. 3 is a cross sectional view showing an essential part of the liquid crystal display panel according to still another embodiment of the present invention.

[Fig. 4]

Fig. 4 is a cross sectional view showing an essential part of the liquid crystal display panel according to still another embodiment of the present invention.

[Fig. 5]

Fig. 5 is a plan view showing a liquid crystal display panel according to still another embodiment of the present invention.

[Fig. 6]

Fig. 6 is a plan view showing a liquid crystal display panel according to still another embodiment of the present invention.

[Fig. 7]

Fig. 7 is a plan view showing a liquid crystal display panel according to still another embodiment of the present invention.

[Fig. 8]

Fig. 8a is a plan view showing an essential part of a liquid crystal display panel according to still another embodiment of the present invention, and Fig. 8b is a cross sectional view taken along an A-A' line of Fig. 8a.

[Fig. 9]

Fig. 9a is a plan view showing a color filter substrate using a liquid crystal display panel according to still another embodiment of the present invention, and Fig. 9b is a plan view showing an essential part of the liquid crystal display panel.

[Fig. 10]

Fig. 10a is a plan view showing an essential part of a liquid crystal display panel according to still another

embodiment of the present invention, and Fig. 10b is a cross sectional view taken along an A-A' line of Fig. 10a.

[Fig. 11]

Fig. 11a is a plan view showing an essential part of a liquid crystal display panel according to still another embodiment of the present invention, and Fig. 11b is a cross sectional view thereof.

[Fig. 12]

Fig. 12a is a plan view showing an essential part of a vertical electric field type liquid crystal display panel according to the prior art, and Fig. 12b is a cross sectional view taken along an A-A' line of Fig. 12a.

[Fig. 13]

Fig. 13a is a plan view showing an essential part of a horizontal electric field type liquid crystal display panel according to the prior art, and Fig. 13b is a cross sectional view thereof.

[Reference Numerals]

1: array substrate

2: color filter substrate

3: sealing material

4: encapsulating material

5: conductive paste

6: protrusion portion

7: liquid crystal layer

8: display region

9: glass plate

10: injecting port

11: gate line

12: source line

13: active element

14: pixel electrode

15: counter electrode

16: black matrix

17: alignment layer

18: pillar shaped protrusion portion

19: color filter

20: storage capacity portion

20a: opening

21: transparent dielectric layer

22: spacer